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ABSTRACT

The shortcomings of the dominant information processing models of cognition are outlined, and two alterative models derived from semiotics are presented. In addition, the possibility of incorporating J. J. Gibson's ecological theory of affordance within the semiotic models is explored as a means of addressing some criticism of the latter models. The semiotic models addressed are J. Deely's (1983, 1986) sensation-based Umwelt model and U. Eco's (1976, 1979, 1984) Model Q. The criticism that semiotic models lead to solipsism is dealt with through Gibson's rejection of perception as based solely on sensation. In his theory of visual perception, Gibson considers the environment to be the surfaces that separate substances from the medium in which animals live. But environments also "afford" things, such as shelter and locomotion. The processes of perceiving affordances and abduction, as described by Deely, allow semiotics to escape solipsism. Five figures are provided. (TJH)

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# Abduction and Affordance: A Semiotic View of Cognition

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# Abduction and Affordance: A Semiotic View of Cognition[1]

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In this paper, I would like to briefly outline the shortcomings of the dominate information processing models of cognition, present two alternative models derived from semiotics and, finally, explore the possibility of incorporating J. J. Gibson's theory of affordance within the semiotic models to address some of the criticisms of them. This is a full agenda for a paper of this length and I will apologize in advance for skimming over some rather complicated and profound issues. What I will be sharing with you today are really matters which I hope to be working on for several years to come, not a completed project. I invite your reactions. (See also Cunningham, in press)

## Cognition as Information Processing

Cognitive information processing models of cognition view man as a symbol manipulator in the same sense that a computer is; that is, both use symbols and perform operations on those symbols. Human intellectual competence is conceived to be the result of a few elementary operations on a set of symbols. These operations, like those of the computer, may be combined, organized and reorganized in predictable ways, and underlie the incredible range of behavior we observe in the human species. Complex skills such as driving an automobile, writing a paper for AERA, solving a waste management problem for a city, monitoring the radar screen in the air traffic control tower at O'Hare, etc., result simply from the operation of these fundamental processes on the human symbol system. The central task that cognitive psychologists have set for themselves is to uncover the nature of these symbols and processes.

But I for one have serious reservations about this paradigm. It, as well as its predecessor, the behaviorist model, assume that human intellectual skills can be decomposed into discrete sets of simple behaviors, symbols or cognitive processes and that higher skills are some concatenation of simpler learnings and/or processes. Knowledge or understanding is viewed as some entity which can be transferred from one place to another (i.e., from the environment to the mind or from one location to another in a memory system). It is as if these symbols completely represent the aspects of the environment they stand for and exist in stable form like bits of information in a computer waiting to be operated upon.

From my admittedly biased perspective, problems have arisen with these views, problems so serious that they are producing cracks in the foundations of current information processing cognitive psychology. A typical scenario is that a theoretical entity is proposed like schema (e.g., Rumelhart and Ortony, 1977) which is then championed for a period of time, then revised to

accommodate to limitations and discrepancies which have arisen, and then finally discarded. To illustrate, Rumelhart (1980) and others have proposed that schemata are the fundamental elements on which all information processing depends. They are "data structures" within which the knowledge stored in memory is represented. Schemata contain "slots" into which incoming knowledge is encoded and stored or from which it is retrieved. At the heart of the research literature is the assumption that it will be possible to somehow accurately portray these schemata (i.e., The burglar schema, the restaurant script, the face frame, etc.) and even construct computer programs which would simulate schema based information processing.

But as more research is done and as the concepts are applied more widely, the cracks become increasingly apparent. Comments like "Of course the choice of schema which might be applied depends on the context"; or "Of course this particular schema is only one of many which must be brought to bear to fully understand this experience" or "Even the simplest event has an infinite number of features which could be attended to". And so forth. The notion that schemata themselves are interrelated in an enormous variety of ways has lead some theorists to begin to explore concepts like tangled hierarchies, metaschemata, spreading activation, executive routines, parallel distributed processing, etc. What is overlooked in this theorizing is that none of the existing models will ever be able to be revised enough to accommodate to the seemingly infinite capacity of humans to understand things from a seemingly limitless number of perspectives. The interconnectedness of all knowledge is not an obstacle to be overcome by our theoretical models--it is the fundamental assumption with which we should start.

## Semiotic Models of Cognition

Let me illustrate how semiotic models of cognition would differ from a cognitive information processing view by briefly reviewing John Deely's Umwelt model and Umberto Eco's Model Q.

### A. Deely (1983, 1986)

Deely's Umwelt model, a term borrowed from the late 19th-early 20th century biologist, Jacob von Uexkull, is shown in Figure 1. An advantage of this notion is that it applies equally well to humans and alloanimals, and, perhaps also to alloorganisms (i.e., plants, microbes, etc.). von Uexkull was interested in characterizing how animals picture the world in their mind and how they then interact with the world as they have circumscribed it. Since animals can only respond to a small portion of the total sensory information available, they create, both as a species and as individual members of a species, an Umwelt, a "subjective environment" which details only those aspects of the physical world which are important (i.e., to be approached, avoided, ignored, etc.). It is crucial to realize the difference between an Umwelt and an environment. An

environment is a physical setting that can be conceived of independently of any particular organism and, in fact, is usually said to exist for all organisms. This separation of organism and environment is a fundamental tenet of cognitive information processing models of cognition. The Umwelt of an organism, however, is not independent of the organism; in fact, it exists only in relation to the organism. Any particular physical entity can serve an enormous variety of Umwelts: the Mariott Hotel in New Orleans can create a shelter from the rain for humans, a nesting site for cockroaches, a landing site for pigeons, a landmark for cab drivers, and so forth. In all cases, the environment of the hotel is the same; that is, the sheltered enclosure, the crevices, the flat surfaces, etc. are available to each of the organisms, yet their experience of them is quite different.

Thus far the discussion of Umwelt applies equally well to both humans and alloanimals. This state of affairs is depicted below the double dashed lines in the drawing by Deely (Figure 1). Sensory information in the form that are traditionally referred to as proper sensibles (i.e., colors, sounds, textures, tastes and odors) and common sensibles (i.e. plurality, shape, position, movement and size) are the raw materials out of which Umwelts emerge both for species and individuals. At the level which Deely labels perception, the Umwelt of the animal emerges; that is, it is both ontologically present and idiographically developed by particular activities and mediated by processes of synthesis, remembering imagining, evaluating and expressing. Via perception, the animal comes to terms with the physical environment, creating and living in a world uniquely defined for that species and that individual. Yet the Umwelt is not static (i.e., in equilibrium) but in a constant state of flux both at the species and individual level (see Anderson et al., 1986).

Semiosis in humans, while based upon the processes described thus far, is qualitatively different from that of alloanimals. Humans can create signs which go beyond the immediate experience of the cognizing organism. Words, pictures, bodily movements and the like generate interpretants for objects which need have no basis in the real world and which can be manipulated independent of that world. Yet these signs come to form a part of the Umwelt of humans in the same way that dark crevices do for an insect. It is the intervention of language, according to Deely, that allows humans to engage in this type of semiosis. Through language, we create culture: governments, armies, schools, art, professional associations, etc. Culture, in turn impacts our lives, by determining what is important, what makes sense, what is to be valued, etc. The <u>arbitrary</u> nature of these signs, their lack of true reality status, is not readily apparent to humans until they are exposed to cultural systems which depart from their own.

The fact that humans can utilize signs which are arbitrary and need have no existence in their immediate experience is what makes thought possible and distinctly human. Deely's diagram

depicts this notion by showing that experience comes to be represented by linguistic signs that can be created without any actual embodiments in the physical world. But these signs come to be part of our Umwelt - note the leftward branching lines that return to the perceptual level, indicating that we tend to see the world anew once some aspect of culture is created.

Figures 2 and 3 show the dynamic aspects of Deely's model. Essentially this is a model of inference. Semiosis is a process of applying signs to understand some phenomena (induction), reasoning from sign to sign (deduction), and/or inventing signs to make sense of some new experience (abduction). The bottom diagram is meant to suggest the cyclic nature of this inferencing process: signs are invented to account for experience, these signs are linked to existing sign structures and then used to define the Umwelt for that organism. But the world is not infinitely malleable to our sign structures and abductive process will be again instigated. Deely is here, in my view, incorporating growth into his model, both from the perspective of ontology and experience.

B. Eco (1976, 1979, 1984)

Umberto Eco's Model Q is best presented by recapitulating his critique of existing models of semantic representation in his book Theory of Semiotics. Figure 4 is an example of a typical model of semantic memory (taken from Katz and Fodor, 1963) in which the meaning, concept, or scheme of bachelor is represented as a hierarchical tree structure. (Eco could just as easily use Collins and Quillian, John Anderson's Act * Theory, Rumelhart's Schema Theory, etc.).

In a brilliant critique of the Katz-Fodor model, Eco raises a number of issues, among which are the following:

1. The K-F model represents the ideal competence of an ideal speaker and is unable to account for the social use of languages with all its living contradictions, illogic, creativity and so forth. The representation of "bachelor" is what one would find in a dictionary where dominate meanings are listed. What is needed is a concrete encyclopedia which lists common social (cultural) beliefs which are sometimes mutually contradictory and always historically rooted, rather than undated, theoretically fixed constructs.
2. A concept's meaning is claimed to be fixed by reference to a finite set of semantic markers which are not subject to further analysis. Thus there are meaning "kernels" to which the meaning of any given concept can finally be reduced. But in fact every marker must be interpreted by other markers (their interpretants) and given that there are an infinite number of potential markers, no "uninterpretable" markers could possibly exist.
3. The K-F model fails to take into account an

infinity of possible ramifications (or connotations). Bachelor frequently connotes--"dissolute young man" or "charming young man" or "fellow on the make" or "homosexual" or "sexual dysfunction" or "woman hater" or "dedicated to his profession", etc. (e.g., Garrison Keillor's Norwegian bachelor farmers).

4. This the model refuses to consider settings or contexts, how a given lexical item can be read one way in one setting, another in another, or even in more than one way at a time (metaphor).
5. The model is limited to the verbal and categormatic. The concept of bachelor immediately suggests to me a visual image of my late uncle who lived with my family throughout my childhood.

Attempts to revise models such as K-F to accommodate these deficiencies seem strained, forced and unsuccessful since the continuing assumption is that knowledge exists somehow independent of the human knowers and the cultural context within which they find themselves.

Eco's proposed alternative to the K-F model will be unsatisfying to many of you because it acknowledges the impossibility of identifying a finite set of representational symbols. Instead it is proposed that representation is a net or labrynith of signs or interpretants of signs, an inconceivable globality. A concrete image may help to communicate this notion. Eco uses a vegetable metaphor of the rhizome--a tangle of bulbs and tubers appearing like rats squirming one on top of the other. Rhizomatic structure may be characterized as follows:

1. Every point of the rhizome can and must be connected with every other point, raising the possibility of an infinite juxtaposition.
2. There are no fixed points or positions in a rhizome, only connections (relationships).
3. A rhizome can be broken off at any point and be reconnected following one of its own lines (or relationships).
4. The rhizome is antigenealogical (which I take to mean is not necessarily hierarchical, and that it is impossible to trace any meaning back to some "kernel").
5. The rhizome whole has no outside or inside.
6. A rhizome is a open chart which can be connected with something else in all of its dimensions; it is dismountable, reversible and susceptible to continual modification.
7. A network of trees which open in every direction can create a rhizome (which is equivalent to saying that a network of partial trees can be "artificially" extracted from every rhizome (see Figure 5).
8. Rhizomes can not be statically pictured without

changing their dynamic, temporal character (uncertainty principle).

9. Since the structure as a whole can not be conceptualized by either the scientist or the user, we are left to "local" experiences. In essence, we are feeling/groping our way along a labyrinth in the same way that Brother William does in The Name of the Rose (Eco, 1983).

A model such as this acknowledges the possibility of unlimited semiosis but at the same time allows us to understand the means by which we do structure our world, to allow us to constrain the potential meanings in particularized ways--through the operation of culture. Knowledge, then, is not "out there" waiting to be discovered. The world, as we know it, is culturally coded. What we experience as reality is really prior cultural codings, prior structures which have been invented by our culture. Eco goes on to detail a brilliant theory of sign production which is beyond our purposes here today.

## Abduction and Affordance

A weakness (or at least a frustration) I have heard expressed about semiotic models of cognition is that they eventually lead to solipsism; that is, these models seem to be implying that organisms can know nothing that they themselves have not created or experienced. While both Deely and Eco propose an interaction between the physical world and the cognizing organism via signs, little is said about the nature of the elements that are interacting. Although we can not know the physical world directly, it surely exists and as such has features which constrain the sign processes. As I dash across Canal Street, I will endeavor to avoid the onrushing traffic in the belief that the cars are real and not the product of my own unique semiosis. Given the relatively consistent nature of sign structures which humans within a particular context develop, what does this suggest about the nature of the physical world?

Deely's model is fundamentally a sensation based model. The physical world is presented to us as bundles of features which we some how synthesize into a perceptual object - a process which sounds a lot like traditional encoding models of perception where impoverished stimulus information is somehow operated on by information processing mechanisms until the information is reorganized into a form consistent with our existing knowledge. But if these features can be combined and recombined in an infinite number of ways, what is the reason for the preeminence of some arrangements over others? Could it be that perception is a function of structures in the physical world, not simply decomposed features and/or constructions of the perceiving organism?

This is essentially the question raised by J. J. Gibson (1979) in his ecological approach to visual perception ( it should be stressed here that Gibson's work is limited largely to

visual perception and can only be analogously applied to other forms of perception and to other cognitive processes. I hope my use of the concepts does not do serious violence to his work!). Gibson begins with a notion all too rare in academic psychology, that his theory of perception must account for ordinary perception, that of organisms moving about in their environment, seeing the ordinary things of daily life. Why, he asks, would it be the case that if perception was simply a construction from sensed features ( and impoverished ones at that) that our perceptions seem to agree so well with the environment through which a multitude of observers move?

Gibson rejects the sensation based theories of perception which regard the perceiver as a passive receiver of impoverished stimulus energy on the basis of which the perceiver transforms a retinal image into a perception. His ecological optics abandons the sensation-perception distinction and proposes instead an ecological model of an active perceiver confronting an information rich stimulus environment. Gibson's notion of environment is very compatible with the idea of the Umwelt. For Gibson, an environment is that which organisms perceive, not the physical world which a physicist might describe. The term refers to the "surroundings" of an organism on a scale appropriate for terrestrial animals (i. e. in terms of terrains, objects, and events which are appropriate for organisms on this planet - sizes between inches and meters, times between seconds and hours, etc.). For Gibson, the words organism and environment are an inseparable pair.... each implies the other. One can not talk of an environment in general but only of an environment with respect to a particular animal.

The terrestrial environment, unlike the physical environment, consists of a medium, substances and surfaces that separate the medium from substances. The medium for humans is the gaseous atmosphere, the "air" which permits unimpeded locomotion from place to place, seeing, smelling and hearing of substances. In our world, the medium has an absolute axis of reference, the vertical axis defined by gravity. Substances are the "things " of the world, the objects or "furniture" which occupy the terrestrial surface. Unlike the medium, substances do not permit locomotion or transmit light. Substances are heterogeneous whereas the medium is relatively homogeneous. Surfaces separate the medium from substances. It is at the level of surface where all of the action in visual perception takes place. We do not perceive the medium or substances but only surfaces where the medium and substances meet. A surface is said to have a layout (form), texture, the property of being lighted or shaded and the property of a certain fraction of the illumination falling on it.

To make a very long story much too short, visual perception arises when structured information from surfaces is perceived. The ambient optical array (this structured information available in light) is described by Gibson as visual solid angles with a common apex at the point of observation. They are angles of intercept which change as the observer moves or the surface(s)

under observation move. But other aspects of the array do not change (e.g. the layout and reflectance). The perceptual system monitors those things that change and those things that persist and from this information perception is developed. Perception is thus a process which develops from the interaction of an active perceiver in an informationally rich environment which is constantly in flux.

Of primary importance for our purposes here is Gibson's theory of affordances. As noted above, Gibson considers the environment to be the surfaces that separate substances from the medium in which animals live. But environments also afford things (such as shelter, locomotion, etc.). There is information in light for perception but also for the perception of what surfaces afford. To perceive something is to perceive what it affords, its value or meaning. To quote Gibson "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill" (p. 127). But affordances do not exist independent of an animal; the term refers to both the environment and animal. "An affordance is neither an objective property nor a subjective property; or it is both if you like... (it) points both ways, to the environment and the observer" (p. 129). The terrestrial surface, for example may be horizontal, flat, extended and rigid, thus affording support to certain terrestrial animals. But this affordance is relative to particular terrestrial animals, not an abstract property of the physical world.

The process of perceiving affordances is called "information pick-up", unfortunately the least developed aspect of Gibson's theory. Affordances are invariants available in the ambient optic array and perception of affordances results from monitoring those aspects of the ambient optic array which persist and those which change. Note that this conception places the affordance in the light, not in the needs or motives of the observer. The potential affordance of a paper clip as a replacement for fishhook is available whether or not it is perceived by a particular organism to which the affordance is relevant.

In my current thinking, the concept of affordance is very relevant to semiotic models of cognition such as those described above. In Deely's model, for example, abduction is a mode of inferencing whereby organisms attempt to make sense of the world by creating sign structures. In essence this process has been likened by Shank (in press) to "reading" the environment. But is our reading free to take any possible form? Can the Umwelt we create be entirely independent of those aspects of the environment relevant to us as a species or as an individual? A fruitful area of research for semioticians will be to investigate the possibilities of affordance-like constancies in our worlds. I fully appreciate the fact that I am making a hugh leap from a model of visual perception to one of cognition, especially a model of cognition with the scope of semiotics. I personally believe the leap is justified.

To close, let me give one brief example of the sort of

analysis I am proposing. Take a typical secondary classroom. Are there affordance-like constancies in this situation that can be read? Clearly the readings can be numerous and relevant to a wide variety of perspectives and contexts. We can analyze the ideational character of the classroom discourse (as Jay Lempke (in press) does), observe the social interactions among the students, chart the patterns of student and teacher questions and answers, and so on and so forth. To what extent do the particular events and circumstances we observe lead us to the identification of this as a classroom, a pedagogical technique of a certain type. What is essential (persistent) and what is changing (variable). Do certain metaphors seem to account for our observations better than others?

The underlying motivation of such research is that over time it will eventually lead to ever more adequate conceptions of the affordances available in this stimulus information. Like Peirce, I believe that our inquiry will eventually lead us closer to the dynamic object, to an undcrstanding of the world as it <u>is</u>, unmediated by signs. But since this quest is of the nature of <u>all</u> cognition, why should our inquiry be any different?

[1] Paper presented at the annual meeting of the American Educational Research Association, New Orleans, April, 1988.

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AERA - 1988

Figure 1

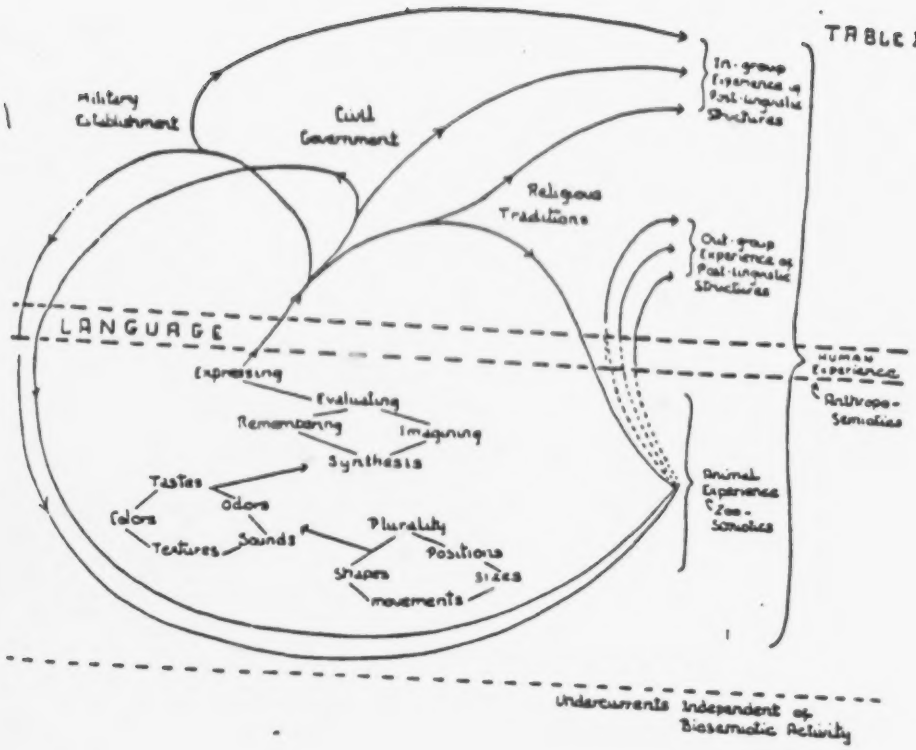



Figure 2

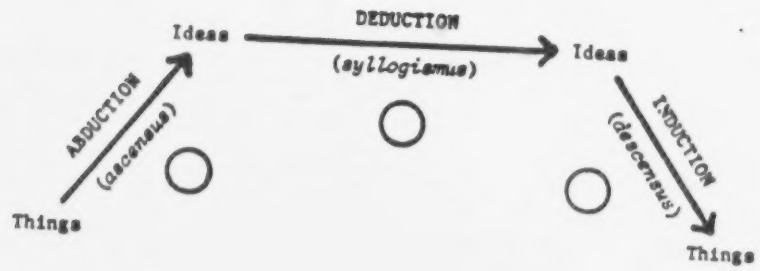
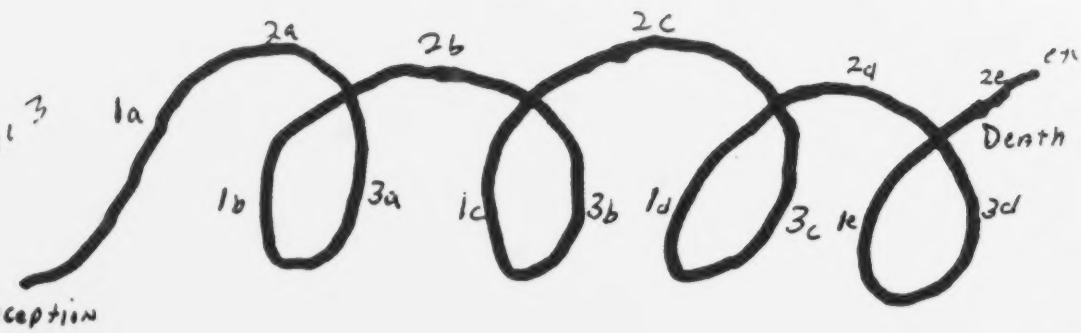



Figure 3




From Deely (1986)



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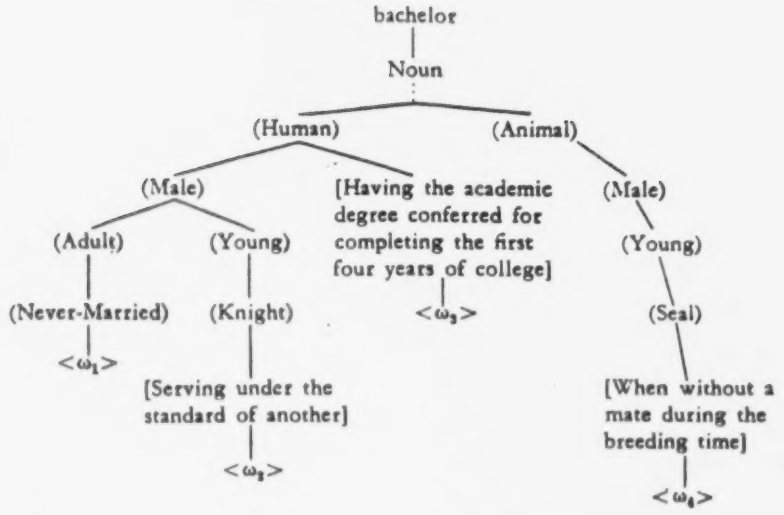
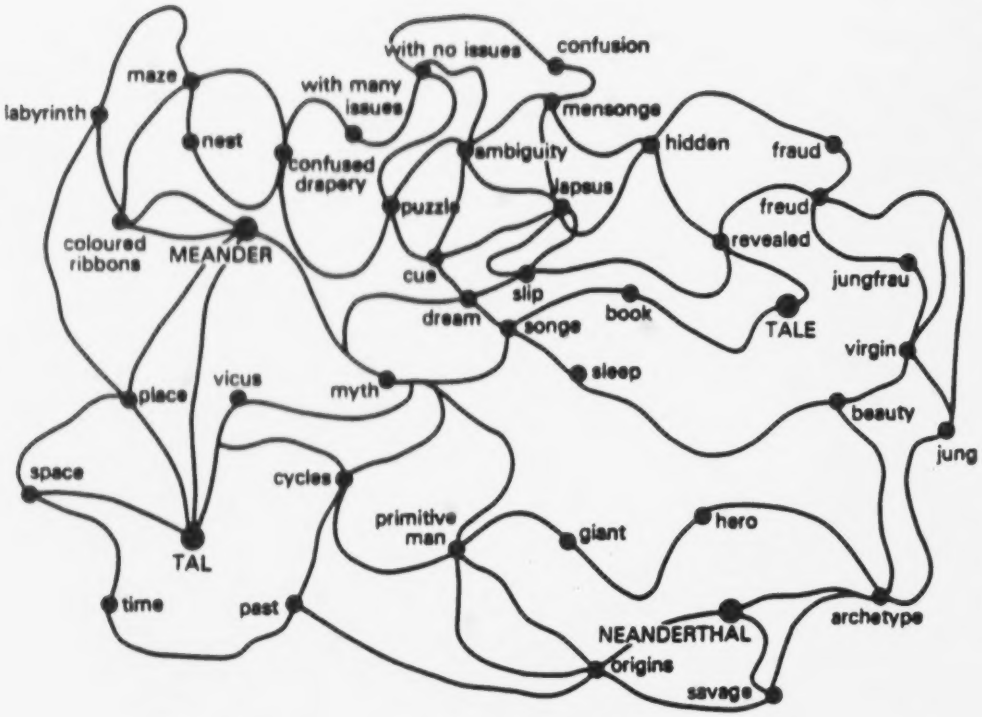
Figure 4




From Katz & Fodor (1963)

Figure 5




From Eco (1979)